Institute of Chemical Engineering

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Laboratory of Gas and Liquid Separation Processes

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Current research activities

Adsorption and membrane gas separation methods

Research is focused on the design, analysis, and optimization of gas separation and purification processes using adsorption, membrane, and hybrid adsorption–membrane technologies. Particular attention is given to separating biogas from various sources into two usable streams, bio-methane and bio-CO2, the production of hydrogen from multicomponent gas mixtures, and the removal of low-concentration carbon dioxide from gas streams released into the atmosphere. Both experimental and theoretical investigations are conducted to characterize the separation properties of porous solid adsorbents and membrane materials. Multi-parameter analysis and process optimization are performed based on experimental results obtained at laboratory and

pilot scales, as well as through the development and application of mathematical models and numerical simulators.

Utilization of alkaline industrial wastes for carbon dioxide sequestration

The carbonation process, which involves the reaction of carbon dioxide with metal oxides, is considered a promising approach for CO_2 sequestration and neutralization. Metal oxides can originate from natural minerals or from alkaline industrial wastes, such as fly ash from coal combustion. The use of industrial wastes significantly reduces the costs of CO_2 sequestration while enabling the utilization of hazardous by-products and the production of valuable, commercially useful materials. Experimental studies are conducted on carbon dioxide binding through mineral carbonation in aqueous environments, using fluidized-bed ashes from lignite combustion. Different technological process configurations, designed to operate under ambient conditions, have been proposed. The developed process flow schemes for CO_2 removal from flue gases using fluidized ashes have been implemented in the AspenPlus, the process simulation software. Simulation studies are being conducted to evaluate the economic feasibility of the carbonation process for different technological variants.

Bubble column process engineering

A thorough understanding of the hydrodynamic regime in which a bubble column operates is essential, as it directly influences mixing efficiency and heat and mass transfer. The research aims to develop flow regime maps for bubble columns operating with liquids of different physicochemical properties. Novel methods for identifying flow regime transition boundaries are being developed, based on statistical information extracted from pressure fluctuation measurements. Analysis of these statistical signals enables the determination of gas velocities at which transitions between operating regimes occur. The proposed methodology is being validated for various liquids, including water, aqueous glucose solutions, alcohols, and salt solutions.

Metryczka

Created by:	Head: dr hab. inż. Marek Tańczyk
Published at:	17.06.2025 14:29
Last edited by:	Marek Tańczyk
Last edited at:	07.05.2026 15:36
Number of views:	166